

Appl. No. 10/789,310
Reply to Office Action of July 27, 2006

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Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1-13 (Canceled).

Claim 14 (Withdrawn): A method for manufacturing a mother die of a mold utilized for molding an optical element having a predetermined diffraction structure, comprising the steps of:

measuring a contour of a substrate, on which said predetermined diffraction structure is depicted, and/or a thickness of a resist film formed on said substrate, so as to detect height errors in surface heights in comparison with specified values of a surface height distribution of said substrate and/or thickness errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

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adjusting a depicting mode for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said height errors and/or said thickness errors detected in said measuring step, so as to compensate for a phase change of diffracted light caused by each of said height errors and/or each of said thickness errors corresponding to each of said diffraction gratings; and

depicting each of said diffraction gratings by scanning an electron beam onto said resist film formed on said substrate, according to said depicting mode adjusted in said adjusting step.

Claim 15 (Withdrawn): The method of claim 14, further comprising the step of:

cutting a material so as to create said substrate from said material.

Claim 16 (Withdrawn): The method of claim 14, further comprising the steps of:

forming said resist film on said substrate; and

developing said resist film, on which said diffraction gratings are depicted in said depicting step, to create said mother die having said predetermined diffraction structure.

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Claim 17 (Withdrawn): The method of claim 14, further comprising the step of:

etching said mother die created in said developing step.

Claim 18 (Withdrawn): A mother die of a mold utilized for molding an optical element having a predetermined diffraction structure, said mother die being manufactured by a method comprising the steps of:

measuring a contour of a substrate, on which said predetermined diffraction structure is depicted, and/or a thickness of a resist film formed on said substrate, so as to detect height errors in surface heights in comparison with specified values of a surface height distribution of said substrate and/or thickness errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

adjusting a depicting mode for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said height errors and/or said thickness errors detected in said measuring step, so as to compensate for a phase change of diffracted light caused by each

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of said height errors and/or each of said thickness errors corresponding to each of said diffraction gratings; and

depicting each of said diffraction gratings by scanning an electron beam onto said resist film formed on said substrate, according to said depicting mode adjusted in said adjusting step.

Claim 19 (Withdrawn): A method for manufacturing mold utilized for molding an optical element having a predetermined diffraction structure, said mold being manufactured from a mother die and said predetermined diffraction structure being transferred to said mold from said mother die by applying electrocast processing, said mother die being manufactured by a method comprising the steps of:

measuring a contour of a substrate, on which said predetermined diffraction structure is depicted, and/or a thickness of a resist film formed on said substrate, so as to detect height errors in surface heights in comparison with specified values of a surface height distribution of said substrate and/or thickness errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

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adjusting a depicting mode for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said height errors and/or said thickness errors detected in said measuring step, so as to compensate for a phase change of diffracted light caused by each of said height errors and/or each of said thickness errors corresponding to each of said diffraction gratings; and

depicting each of said diffraction gratings by scanning an electron beam onto said resist film formed on said substrate, according to said depicting mode adjusted in said adjusting step.

Claim 20 (Withdrawn): A mold utilized for molding an optical element having a predetermined diffraction structure, said mold being manufactured from a mother die and said predetermined diffraction structure being transferred to said mold from said mother die by applying electrocast processing, said mother die being manufactured by a method comprising the steps of:

measuring a contour of a substrate, on which said predetermined diffraction structure is depicted; and/or a thickness of a resist film formed on said substrate, so as to detect height errors in surface heights in comparison with

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specified values of a surface height distribution of said substrate and/or thickness errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

adjusting a depicting mode for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said height errors and/or said thickness errors detected in said measuring step, so as to compensate for a phase change of diffracted light caused by each of said height errors and/or each of said thickness errors corresponding to each of said diffraction gratings; and

depicting each of said diffraction gratings by scanning an electron beam onto said resist film formed on said substrate, according to said depicting mode adjusted in said adjusting step.

Claim 21 (Withdrawn): An optical element, molded by utilizing a mold and having a predetermined diffraction structure, said mold being manufactured from a mother die and said predetermined diffraction structure being transferred to said mold from said mother die by applying electrocast processing, said mother die being manufactured by a method comprising the steps of:

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measuring a contour of a substrate, on which said predetermined diffraction structure is depicted, and/or a thickness of a resist film formed on said substrate, so as to detect height errors in surface heights in comparison with specified values of a surface height distribution of said substrate and/or thickness errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

adjusting a depicting mode for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said height errors and/or said thickness errors detected in said measuring step, so as to compensate for a phase change of diffracted light caused by each of said height errors and/or each of said thickness errors corresponding to each of said diffraction gratings; and

depicting each of said diffraction gratings by scanning an electron beam onto said resist film formed on said substrate, according to said depicting mode adjusted in said adjusting step.

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Claim 22 (Withdrawn): An apparatus for depicting a predetermined diffraction structure on a substrate by scanning an electron beam onto said substrate, comprising:

an electron-beam scanning section, that includes an electron-beam irradiating device to irradiate said electron beam and an electron-beam deflecting device to deflect said electron beam irradiated by said electron-beam irradiating device, to scan said electron beam onto said substrate;

a contour measuring section to measure a contour of said substrate so as to detect height errors in surface heights in comparison with specified values of a surface height distribution of said substrate;

a depicting-mode adjusting section to adjust a depicting mode for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said height errors detected by said contour measuring section, so as to compensate for a phase change of diffracted light caused by each of said height errors corresponding to each of said diffraction gratings; and

a controlling section to control said electron-beam scanning section so as to depict each of said diffraction gratings by

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scanning said electron beam onto said substrate, according to said depicting mode adjusted by said depicting-mode adjusting section.

Claim 23 (Withdrawn): The apparatus of claim 22,
wherein said depicting mode represents each spacing between said diffraction gratings.

Claim 24 (Withdrawn): The apparatus of claim 23,
wherein said depicting-mode adjusting section adjusts a space between said diffraction gratings to a small value when a concerned error, being one of said height errors, is positive, while adjusts a space between said diffraction gratings to a large value when a concerned error, being one of said height errors, is negative.

Claim 25 (Withdrawn): The apparatus of claim 22,
wherein said depicting mode represents a dose of said electron beam for depicting each of said diffraction gratings.

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Claim 26 (Withdrawn): The apparatus of claim 25,

wherein, when a concerned error being one of said height errors is positive, said depicting-mode adjusting section adjusts said dose of said electron beam to a large value, to such an extent that it is equivalent to an amount for depicting said concerned error, while, when a concerned error being one of said height errors is negative, said depicting-mode adjusting section adjusts said dose of said electron beam to a small value, to such an extent that it is equivalent to an amount for depicting said concerned error.

Claim 27 (Withdrawn): An apparatus for depicting a predetermined diffraction structure on a substrate by scanning an electron beam onto said substrate, comprising:

an electron-beam scanning section, that includes an electron-beam irradiating device to irradiate said electron beam and an electron-beam deflecting device to deflect said electron beam irradiated by said electron-beam irradiating device, to scan said electron beam onto said substrate;

a film-thickness measuring section to measure a thickness of a resist film formed on said substrate so as to detect thickness

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errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

a depicting-mode adjusting section to adjust a depicting mode for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said thickness errors detected by said film-thickness measuring section, so as to compensate for a phase change of diffracted light caused by each of said thickness errors corresponding to each of said diffraction gratings; and

a controlling section to control said electron-beam scanning section so as to depict each of said diffraction gratings by scanning said electron beam onto said resist film, according to said depicting mode adjusted by said depicting-mode adjusting section.

Claim 28 (Withdrawn): The apparatus of claim 27,

wherein said depicting mode represents each spacing between said diffraction gratings.

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Claim 29 (Withdrawn): The apparatus of claim 28,

wherein said depicting-mode adjusting section adjusts a space between said diffraction gratings to a small value when a concerned error, being one of said thickness errors, is positive, while adjusts a space between said diffraction gratings to a large value when a concerned error, being one of said thickness errors, is negative.

Claim 30 (Withdrawn): The apparatus of claim 27,

wherein said depicting mode represents a dose of said electron beam for depicting each of said diffraction gratings.

Claim 31 (Withdrawn): The apparatus of claim 30,

wherein, when a concerned error being one of said thickness errors is positive, said depicting-mode adjusting section adjusts said dose of said electron beam to a large value, to such an extent that it is equivalent to an amount for depicting said concerned error, while, when a concerned error being one of said thickness errors is negative, said depicting-mode adjusting section adjusts said dose of said electron beam to a small value, to such an extent that it is equivalent to an amount for depicting said concerned error.

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32. (New) A method for depicting a predetermined diffraction structure on a substrate by scanning an electron beam onto said substrate, comprising the steps of:

measuring a thickness of a resist film formed on said substrate so as to detect thickness errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

adjusting each spacing between diffraction gratings which constitute said predetermined diffraction structure, in response to said thickness errors detected in said measuring step, so as to compensate for a phase change of diffracted light caused by each of said thickness errors corresponding to each of said diffraction gratings; and

depicting each of said diffraction gratings by scanning said electron beam onto said resist film, according to said spacing adjusted in said adjusting step.

33. (New) The method of claim 32, wherein, in said adjusting step, a space between said diffraction gratings is adjusted to a small value when a concerned error, being one of said thickness errors, is positive, while a space between said diffraction gratings is adjusted to a large value when a concerned error, being one of said thickness errors, is negative.

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34. (New) The method of claim 32, wherein a contour of said substrate, onto which said diffraction gratings are depicted, has a curved surface.

35. (New) A method for depicting a predetermined diffraction structure on a substrate by scanning an electron beam onto said substrate, comprising the steps of:

measuring a thickness of a resist film formed on said substrate so as to detect thickness errors of said resist film in comparison with specified values of a film thickness distribution of said resist film;

adjusting a dose of said electron beam for depicting each of diffraction gratings, which constitute said predetermined diffraction structure, in response to said thickness errors detected in said measuring step, so as to compensate for a phase change of diffracted light caused by each of said thickness errors corresponding to each of said diffraction gratings; and

depicting each of said diffraction gratings by scanning said electron beam onto said resist film, according to said dose of said electron beam adjusted in said adjusting step.

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36. (New) The method of claim 35, wherein, in said adjusting step, when a concerned error being one of said thickness errors is positive, said dose of said electron beam is adjusted to a large value, to such an extent that it is equivalent to an amount for depicting said concerned error, while, when a concerned error being one of said thickness errors is negative, said dose of said electron beam is adjusted to a small value, to such an extent that it is equivalent to an amount for depicting said concerned error.

37. (New) The method of claim 36, wherein a contour of said substrate, onto which said diffraction gratings are depicted, has a curved surface.